Castilleja linariifolia

Castilleja

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Back from the Extirpated:

Mystery wormwood (*Artemisia biennis var. diffusa*)

By Bonnie Heidel, WYNDD

The summer of 2020 may go down in the record books for strangeness. *What a perfectly good time for Mystery wormwood* (*Artemisia biennis* var. *diffusa*) *to appear* - a plant that had only been found once in Wyoming, in 1980, only to vanish from view.

Mystery wormwood was described by Dr. Robert Dorn in 1988 based on his 1980 collection north of Point of Rocks in the Rock Springs Uplift, Sweetwater County. At least eight times since 1980, botanists searched for it at the same place, without success. Extensive surveys of potential habitat by Wyoming Natural Diversity Database botanists in 1998 lead to the interpretation that it was possibly extirpated.

Walter Fertig hypothesized that it may appear only when conditions are favorable for germination (Fertig et al. 1999). Dorn suspected that plants may require very exact moisture conditions to germinate.

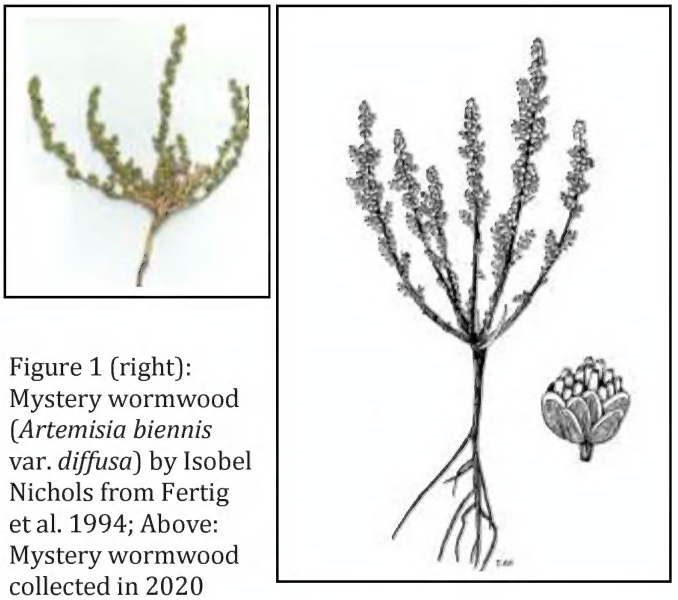

Figure 1 (right): Mystery wormwood (*Artemisia biennis* var. *diffusa*) by Isobel Nichols from Fertig et al. 1994; Above: Mystery wormwood collected in 2020 (*Heidel 5025*).

A perplexing wormwood was observed by Dr. Kim Anderson in 1996 in Dixie National Forest (Utah) and he collected a voucher in 1999 that was verified by Dorn as *A. b.* var. *diffusa.* This new location may have added more questions than answers, coming from the Colorado Plateau, nearly 300 miles away.

This past summer, I sought out wetlands of the Great Divide Basin and beyond in surveying for persistantsepal yellowcress (*Rorippa calycina*) in its natural habitat. One bright July morning, I saw *R. calycina* growing side-by-side with an *Artemisia* that looked strangely like *A. b.* var. *diffusa* (Figure 1). It took three trips to the particular swale before I finally found it in full flower, when the real detective work started. (*Cont. p. 10*)

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WYNPS News

Call for Nominations: Are YOU interested in being on the Board of Wyoming Native Plant Society? Nominations are invited – please send your name to wynps@wynps.org or contact the Secretary Treasurer. The deadline is 23 Nov.

New Members: Please welcome the following new members to WYNPS: CJ Corley, Colorado Springs, CO; Maggie Hunter, Jackson; Nancy Loomis, Cheyenne; Tara Lord, Cody; Kristen Smith, Pinedale

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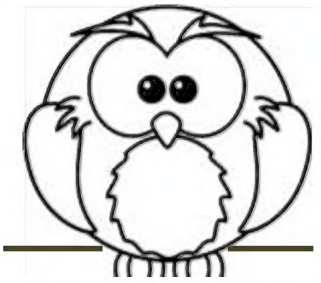
Treasurer's Report: Balance as of 31 Aug 2020: Scholarship = $50; General = $7718.51
Total = $7768.51.

Covid Corner: Stories about your plant pursuits, challenges and surprises in the summer of 2020 are invited.

Message from the President



Autumn Greetings!

All summer, an ever-changing burst of vividly colored wildflowers served as a heartwarming antidote to necessary social distancing. During fall, natural color shifts as leaves turn gold, orange, lemon yellow, deep dark red and almost purple. Leaves of native shrubs and wildflowers lose their chlorophyll, allowing other leaf pigments their time for prominence. Fall splashes of vibrant color have always seemed to me like nature's consolation for the cessation of flowering. My interpretation lacks any scientific credibility, but especially this year I'll gladly seek and accept all soothing comfort the natural world has to offer. Fall also offers me a challenge to identify plants from a distance by their splashes of color on the landscape. This annual display and the few remaining wildflowers enliven fall hikes.

Rabbitbrush and other late-blooming wildflowers attract butterflies such as Milbert's tortoiseshell. These and other anglewing butterflies will overwinter as adults, surviving because as larvae they consumed plants rich in glycerol and other chemicals that serve as antifreeze. We have a different option: retrieve our store-bought adaptations, our warm winter clothes, so that we can venture outdoors to marvel at native plants while we embrace fall and winter in Wyoming!

Please take extra good care of yourselves!

~Katy Duffy

Contributors to this Issue: Robert Dorn, Katy Duffy, Bonnie Heidel, Alice Stears, Dorothy Tuthill.

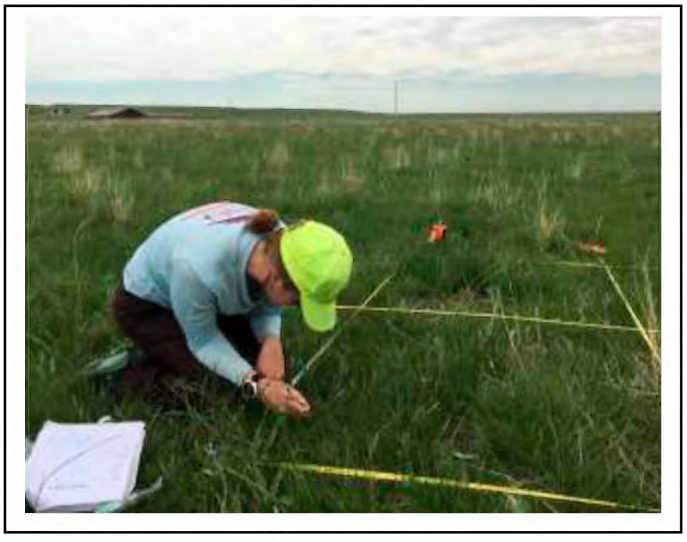
Next Issue: Please send articles and announcements by 15 November to:

Wyoming Native Plant Society
P.O. Box 2449
Laramie, WY 82073

Population Dynamics of a Rare Plant, Colorado butterfly plant (*Oenothera coloradensis*)

By Alice Stears, Department of Botany, University of Wyoming

Wyoming has had four species of plants protected under the Endangered Species Act (ESA) of 1973, ranging from the delicate Ute ladies'-tresses (*Spiranthes diluvialis*) to the sand-dune dwelling blowout penstemon (*Penstemon haydenii*). But after December 5, 2019, the state is down to only three protected plant species (USFWS 2019). The Colorado butterfly plant (*Oenothera coloradensis*), which was listed as 'threatened' under the ESA in 2000, was removed from the Federal List of Endangered and Threatened Plants in 2019 due to recovery, and is "no longer likely to become endangered in the near future."1 From our human perspective, the protective status, and even the name of this perennial forb have changed a bit over the last several decades. But how have things changed from the plant's perspective?



Above: Probing Colorado butterfly plant life history, by Alice Stears

Oenothera coloradensis is a monocarpic perennial forb, meaning it is a non-woody flowering plant that lives for more than one season, but only flowers once in its lifetime. They typically live for two or three years, flower and set seed, and then die. *O. coloradensis* thrives in unshaded riparian habitat, so populations are most often found along streams or in wet meadows. Known populations are located in southeastern Wyoming, northern Colorado, and southwestern Nebraska. While this species is most likely naturally rare, disturbance and loss of riparian habitat over the last century due to development, agriculture, or other means has likely been the driving cause behind dwindling population sizes. Although it makes the future of this species somewhat tenuous, the natural rarity of *O. coloradensis* is also a factor that makes this species an interesting subject for study. Uncovering the evolutionary causes of rarity and the mechanisms that allow small populations to persist is an active area of research in population ecology.

Left: Colorado butterfly plant, by Alice Stears

In order to better understand this species' demographic trends, the Wyoming Natural Diversity Database (WYNDD) began an annual census of flowering *O. coloradensis* individuals on the F.E. Warren Air Force Base near Cheyenne, WY in1986. The Base harbors one of the largest known populations of *O. coloradensis*, and the only on federal land, with sub-populations occurring along three small creeks that flow through the base. These annual counts have been conducted every year since then with only one exception, which has provided a picture of long-term fluctuation in

survival patterns for this species and has allowed managers to make data-informed conservation decisions. There have also been several counts of *O. coloradensis* populations at the Soapstone Prairie Natural Area, a city of Fort Collins property in northern Weld County, CO. Although these counts have not been as frequent as those at the Base, they indicate that the Soapstone Prairie population is the largest one of this species.

Counts of adult plants are an invaluable tool for identifying and predicting long term trends in population sizes, there are other scientific study methods that can give us even more detailed information about demographic processes (such as germination rates, lifespan, death rates, flowering rates, etc.). In-depth information about demographic processes and their relative importance for a population allows us to make even more informed management and conservation decisions. For example, we can identify which of the seedling, vegetative, or adult life stages is more important for maintaining population growth, and then focus conservation efforts on protecting that life stage. Sandra Floyd monitored three sub-populations of *O. coloradensis* at the Base, and used a method called Stage-based Matrix Population Modeling to identify that surviving from a seedling to a small non-reproductive plant, and surviving from a large non-reproductive plant to a flowering plant are the two most important transitions for maintaining population growth in these populations (Floyd and Ranker 1998).

My work on this species for a chapter of my dissertation builds on the work of WYNDD, Floyd, and others to update and improve our understanding of demographic patterns in *O. coloradensis*, and to identify the biological mechanisms that allow small populations of this rare species to persist. We have monitored over 3,000 individuals in six subpopulations of *O. coloradensis* at both the Air Force Base and Soapstone prairie over three growing seasons (2018-2020). For each plant, we know when it germinated, whether it survived from year to year, how much it grew, whether it survived to flower, and if so, how many seeds it produced. We don't know whether a seedbank is important for this species, so we've done greenhouse experiments with field-collected seeds to estimate how many *O. coloradensis* seeds exist in the soil as a seedbank, and for how long. We've also measured environmental variables such as soil moisture and temperature at each sub-population. I am using a more modern form of population model called an Integral Population Model (IPM), which allows us to determine the probability of growth, survival, and reproduction based on the unique size of an individual plant, rather than its age or 'size class' (which is a relatively arbitrary, researcher-defined category),
It will allow us to incorporate data about environmental variation directly into the models as done for other species (Dibner et al. 2019).

These updated population models will allow us to further-refine our understanding of the demographic transitions that are important for *O. coloradensis*, and can help determine which environmental characteristics of a habitat are most conducive to population growth. Finally, I will use this detailed understanding of *O. coloradensis* demographic patterns across sub-populations to identify the biological processes that allow this rare plant to exist, even with such small population sizes and such a small native range. Funding from the Wyoming Native Plant Society has made my work on *Oenothera coloradensis* possible, for which I am extremely thankful! I look forward to being able to share my final results with all of you. I hope that our work will help inform a science-based approach to management of this species moving forward, and keep this beautiful and special plant on our Wyoming landscape!

(*Editor's note: Alice Stears is 2019 recipient of the Wyoming Native Plant Society Scholarship.*)

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Growing Native Plants

Part 37. More Forbs for Dryer Sites

By Robert Dorn

Castilleja angustifolia, Narrowleaf Indianpaintbrush, is a perennial to 12 inches tall and half as wide, usually with several stems, and is parasitic on roots of nearby plants. The leaves are very narrow, to 2 inches long, and usually 3 lobed at the tip. The flowers are greenish and inconspicuous, mostly hidden among the large, usually orange, pink, or red bracts. The flowers appear from May to July but the bracts are showy for most of the summer. The plants occur naturally in open areas of the plains, basins, valleys, and mountains, often growing with sagebrush which is often the host plant. They prefer full sun and moist to dry, well drained soils. It can be grown from seed but must be grown with another plant, preferably Big Sagebrush or Rubber Rabbitbrush, which can serve as a host. Germination may be slow. Cold stratify for 30 days or more or plant outside in the fall. Surface sow to allow light exposure. Seed is commercially available. Variety *dubia* (*Castilleja chromosa*) is more attractive than var. *angustifolia*.

Castilleja angustifolia var. dubia, Uintah County, UT

Liatris punctata, Prairie Blazingstar, is a perennial to 1.5 feet tall and 8 inches wide. The leaves are narrow and to 6 inches long. The flowers are pink-purple and are in heads scattered along the upper stem in a spike-like inflorescence. They appear from July to September. The plants occur naturally in dry, open areas on the plains. They prefer full sun and tolerate many soils. They are drought tolerant. It can be easily grown from fresh seed barely covered with soil. They are difficult to transplant. It is in the nursery trade.

Liatris punctata, Albany County

Phlox longifolia, Longleaf Phlox, is a perennial to 8 inches tall and 5 inches wide, rarely taller. The leaves are opposite, very narrow, and to 3.5 inches long. The flowers are light pink, lavender, or white, to 1 inch across, loosely clustered at tips of stems, and appear from April to July. The plants occur naturally in moist to dry, rocky places or in sand in the plains and basins. They prefer full sun and dry, well drained soils. They are drought tolerant. It can be grown from seed surface sown outdoors in the fall. It is also in the nursery trade.

Phlox longifolia, Dolores County, CO

Townsendia exscapa, Stemless Daisy, is a perennial to 3 inches tall. The leaves are narrow and all basal. The flower heads are to 1.5 inches across and are sessile among the leaves with white or pinkish rays and yellow disk flowers and appear from April to June. The plants occur naturally in dry, open areas on the plains. They prefer full sun and dry to slightly moist soils. It is easy to grow from fresh seed covered lightly with soil.

Townsendia exscapa, Goshen County

Townsendia grandiflora, Largeflower Daisy, is a biennial or short-lived perennial to 8 inches tall and wide, somewhat sprawling, and usually with several stems. The leaves are narrow and to 3 inches long. The flowers are in heads to 1.75 inches across terminating the stems and branches, the rays white and the disk flowers yellow. They appear from April to July. The plants occur naturally in dry, open places on the plains. They prefer full sun and dry, well drained soils. It is easy to grow from seed lightly covered with soil. It is in the nursery trade.

Townsendia grandiflora, Goshen County

To see the above plants in color, go to the newsletter on the Society website.

Not All Coronas are Sinister

By Michael Mancuso, Pahove Chapter

(*Reprinted from Sage Notes 42(1), newsletter of Idaho Native Plant Society, June 2020*)

Corona is one of those English language words with multiple definitions. Lately, it has become a consistent headline in the news due to COVID-19, a disease caused by a type of coronavirus that emerged from China in late 2019. Named for their appearance when viewed under a powerful microscope, the surface of a coronavirus is covered with crown-like spikes. This represents one definition for corona - a crown-like upper portion of a body part or structure. I first learned the word 'corona' as that luminous halo around the moon and sun caused by light diffracting through thin clouds or haze. Similarly, the corona is that aura of highly ionized gas that surrounds the sun and other stars, extending into space for vast distances. But corona is also a cigar with a long, tapering body and blunt ends or, in the parlance of architecture, the top projecting part of a cornice (a type of decorative moulding on buildings). Corona has several medical connotations as well.

So perhaps it should come as no surprise that corona is also a botanical term - referring to petal-like or crown-like appendages between the petals and stamens in some flowers. Daffodils (*Narcissus* sp.), milkweeds (*Asclepias* sp.), and

passionflower (*Passiflora* sp.) are some plant genera with a corona with which you may be familiar. In daffodils, the six petal-like tepals are surmounted by a cup- or trumpet-shaped corona that is often a contrasting color. The floral complexity of milkweeds is largely related to variations in the horn-shape and hood-shape coronas. In the milkweeds, the corona lobes (horns and hoods; Figure 1) function as nectar receptacles effectively serving to position an insect into proper alignment for removal or insertion of pollen (pollinia). The usually colorful and elaborate corona of a passionflower also serves to attract pollinators and guide them to a nectar source. Flowers can amaze us with their beauty and complexity. The presence of a corona only enhances this wonder.

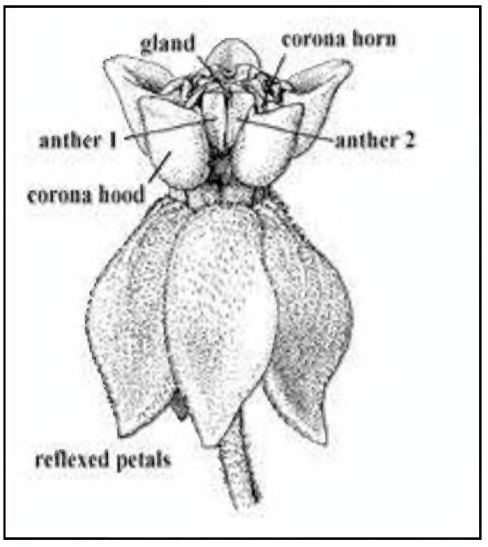


Figure 1. Corona of milkweed (*Asclepias* sp.)

Pandemic pursuits

Rogue Botanists Spread Plant Graffitti

(What's an urban botanist to do in quarantine? The following information is taken from *The Guardian*, May 1, 2020, posted at: https://www.theguardian.com/environment/2020/may/01/not-just-weeds-how-rebel-botanists-are-using-graffiti-to-name-forgotten-flora-aoe .)

An international force of rebel botanists armed with chalk has taken up "pavement chalking" to identify and draw attention to urban plants, springboard for learning the names and importance of the diverse but downtrodden flora growing in the cracks of paths and walls in towns and cities across Europe.

The idea of naming wild plants wherever they grow – which began in France – has gone viral, with people chalking and sharing their images on social media. More than 127,000 people have liked a photo of chalked-up tree names in a London suburb, while a video of botanist Boris Presseq of Toulouse Museum of Natural History chalking up names to highlight street flowers in the French city has had 7m views.

Pavement chalking to draw attention to urban plants has gone viral across the continent. But UK chalkers could face legal action where it is illegal to chalk anything – hopscotch, art or botanical names – on paths or highways without permission, even if it educates, celebrates and fosters interest and knowledge in nature.

French botanist and campaigner Sophie Leguil, who lives in London, set up the More Than Weeds campaign (https://morethanweeds.co.uk/) to change public perceptions of urban plants in the UK after helping to spread the *Sauvages de ma rue* ("wild things of my street") chalking campaign in France. She has won permission to chalk up Hackney's highways and make chalk trails to highlight the forgotten flora at our feet and is asking other councils to allow the same. Leguil stated:

> *"We talk a lot about plant blindness – what if putting names on plants could make people look at them in a different way? I despair at how sanitised London has become. Plants can be managed differently, with benefits – cost-saving, biodiversity, education."*

UK Plantlife spokesman Trevor Dines said, that while the charity does not condone breaking the law:

> "*The incredible response to graffiti plant names is astonishing and I think it's part of something profound. It's as if the plant is declaring its own place in our world.*"

Ten Things You Always Wanted to Know about Sagebrush (but were afraid to ask)

By Walter Fertig

[Editor's note: The following is reprinted from *Sego Lily*, Utah Native Plant Society - July 2008 31 (4)]

Sagebrush is one of the most widely distributed and iconic plants of the American west, and yet also one of the least understood and appreciated. In the interests of increasing the SIQ[1] of our readers, the Sego Lily offers the following ten sagebrush factoids (in no particular order):

#1. Not all "sages" are sagebrush. True sagebrush belongs to the genus *Artemisia*, a group of more than 100 species in the sunflower family (Asteraceae or Compositae) distributed across northern Asia, Europe, western North America, and South America. The common name sage comes from the aromatic foliage that smells much like culinary sage (see # 3) and its relatives in the genus *Salvia*, which are all in the mint family (Lamiaceae or Labiate). Pioneers traveling across the western prairies and deserts applied the term "sage" to a number of shrubby species that had bluish-green foliage, inconspicuous flowers, or odoriferous leaves that are not true mints or members of genus Artemisia. The Latin name comes from Artemisia, queen of Caria (in modern Turkey) in the 4th Century BC, who was an amateur botanist and herbalist. She in turn was named after Artemis, the Greek goddess of the moon, hunting, and wild animals.

#2. There isn't just one kind of sagebrush, there are 69! Dr. Leila Shultz of Utah State University and author of the chapter on *Artemisia* in the Flora of North America (2006) accepts 51 species and 18 subspecies of *Artemisia* and *Picrothamnus* (traditionally included in *Artemisia*) in North America north of Mexico. In Utah, Dr. Stanley Welsh of Brigham Young University recognizes 23 taxa (31 if subspecies are included) of sagebrush. Only half of our sagebrush species are woody shrubs or subshrubs - the others are annual or herbaceous perennials that are often called sageworts or mugworts. All sagebrushes are characterized by numerous small flower heads with rayless florets and tiny seeds lacking a pappus of bristles or scales for dissemination. Within the aster family, sagebrushes are most closely related to yarrow, chamomile, ox-eye daisy, and chickensage (*Sphaeromeria*).

Of our shrubby species, Big sagebrush (*Artemisia tridentata*) is the most abundant and variable. Shultz recognizes 4 subspecies in Utah, each adapted to different soil types or elevation zones. Basin big sagebrush (ssp. *tridentata*) is our most common form and occurs abundantly on deep sandy soils or stream terraces. Mountain big sagebrush (ssp. *vaseyana*) occurs in mountain meadows and Wyoming big sagebrush (ssp. *wyomingensis*) is found on clay-rich sites. Other common shrubby *Artemisia* species in Utah include Bigelow's sagebrush (A. *bigelovii*) found mostly on rocky ledges; Silver sagebrush (*A. cana*), of montane riparian habitats; Black sagebrush (*A. nova*) from limestone or shallow soils; and Sand sagebrush (*A. filifolia*) with very slender leaves found mostly on sand dunes.

#3. If the recipe calls for "sage", don't put in sagebrush! Culinary sage (*Salvia officinalis*) is the spice used for seasoning foods with a sage smell. Native Americans did not cook with sagebrush, but did use it as a medicinal plant. Most often it was used as a tea or poultice to treat colds, fever, toothache, or to induce vomiting (an outcome most chefs are not looking for!). Branches were also burned to purify the air.

#4. Sagebrush really is a flowering plant. Individual sagebrush flowers are quite tiny (1.5-3 mm), lack showy petal-like ray flowers, and are brownish-green. Like other members of the sunflower family, the flowers are aggregated into small heads, each of which is enclosed in an involucre of greenish-gray leaf-like bracts. These flower heads are themselves arranged in branching, panicle-like flower stalks (inflorescences) that often stick out well above the foliage. The flowers are designed for wind

[1] Sagebrush Intelligence Quotient

pollination. Nearly all sagebrush species flower in late summer or early fall (the exception being Bud sagebrush, *Artemisia spinescens*, which flowers in mid spring). Wind-pollinated plants typically produce large quantities of very small pollen that waft through the breeze to randomly reach receptive stigmas on other plants. Many people with fall "hay fever" are allergic to sagebrush pollen, or pollen of herbaceous ragweeds (*Ambrosia* species). Old flowering stalks typically persist for nearly a year and are useful for distinguishing some species, such as Black sagebrush and Big sagebrush. Sagebrush species can produce large crops of tiny seeds each fall, which can be spread over large distances by wind gusts or, more frequently, fall near the parent plants.

#5. Some sagebrush species and subspecies can be identified by their unique leaf chemistry. Scientists have discovered that the presence and quantity of coumarin in leaf tissues can be used to differentiate some sagebrush taxa based on fluorescence of twigs placed in water under UV light. The higher the concentration of coumarin, the brighter the sample will fluoresce, while specimens without coumarin won't fluoresce at all. Presence of coumarin is also correlated with palatability. Those taxa with high concentrations generally are favored over those without (one exception is Wyoming big sagebrush, which does not fluoresce but is one of the more palatable taxa).

All sagebrushes get their distinctive sage odor from chemical compounds such as terpenes and sesquiterpene lactones. The intent of these chemicals is to reduce herbivory by insects and large mammals (including livestock). But not all chemicals are the same - their quantity and type directly influences the palatability of sagebrush foliage. Sage grouse and mule deer preferentially forage on sagebrush species with lower concentrations of these compounds. The amount of leaf chemicals differs between plants based largely on genetics, but can also vary seasonally and even from morning to evening.

#6. Big sagebrush produces two different kinds of leaves. Like most shrubby sagebrushes, Big sagebrush is evergreen, but individual leaves may be relatively short-lived. Overwintering leaves last for about a year and are short and typically clustered. These are capable of undergoing photosynthesis, even at relatively low winter temperatures. Longer ephemeral leaves are formed in the spring and occur singly on the stems. These leaves are shed when hot, droughty conditions occur in the summer, as their larger surface area makes them more prone to water loss than the evergreen leaves. Overwintering and ephemeral leaves usually have three lobes across their tip, while leaves associated with flowering stalks are often entire (unlobed). Leaf shape (elongate vs. bell-shaped) and length are used for distinguishing Big sagebrush subspecies, but can often be extremely variable on the same plant. The distinctive bluish-green color of sagebrush comes from the dense mat of hairs that cover most of its foliage. These hairs reflect some sunlight and provide shade to the leaf and stem surface, keeping them cooler and reducing water loss through transpiration. The hairs may also interfere with herbivory by insects.

#7. Sagebrush can be completely defoliated and survive. Severe drought in southern Utah in 2002 prompted many sagebrushes to shed their leaves to preserve water. The drought was followed by an outbreak of Army cutworm caterpillars which subsequently defoliated many plants. Though they appeared dead, most of the shrubs survived this one-two punch. Big sagebrush does not survive after a fire, however, and is not able to resprout from its roots. The related Silver sagebrush is able to resprout if burned.

#8. Big sagebrush produces two kinds of roots. Like many aridic shrubs, Big sagebrush grows deep taproots up to 20 feet long. In general, root depth is 3-4 times greater than the height of the plant and varies depending on the depth and rockiness of the soil. Big sagebrush also produces lateral roots that radiate out from the plant a short distance below the soil surface. These roots are especially effective at capturing surface moisture following rain or snowmelt. The range of sagebrush strongly correlates with areas where precipitation comes mostly from snow. This accounts for the rarity or absence of

sagebrush vegetation in grass-dominated ecosystems such as the Great Plains where most precipitation comes as summer rain. The presence of lateral roots and competition for water may help explain the natural spacing of sagebrushes and gaps that form between plants. In the past, range managers suspected that sagebrush leaves and roots exuded chemicals into the soil that inhibited growth of competing plants (a condition called allelopathy). Scientific analysis of leaf and soil chemicals, however, provide no basis for this assumption. In fact, grass and forb species are more likely to grow under the canopy of sagebrush where they are partly protected from herbivores and provided shade (which also keeps the soil moister). Rather than inhibiting other plants, sagebrush acts as a nurse plant that improves the probability of seedling survival.

#9. Big sagebrush produces wood and annual growth rings, just like many trees. Although not especially thick, the main stems of Big sagebrush regularly grow a new ring of woody tissue (water-conducting xylem) each year. These growth rings reflect climatic conditions, with thicker rings produced during wetter years and thin rings during times of drought. Patterns in the annual production of rings can be used to date the age when a sagebrush plant became established and to assess variations in past climate. Researchers studying age rings within sagebrush populations typically find that shrubs are of similar ages, suggesting that seedling establishment is infrequent and episodic. They have also found that stem size does not reflect age - large sagebrushes attain their size because they grow in favorable environments and not because of their longevity.

#10. Contrary to what you may have heard, sagebrush is quite valuable to wildlife for food and shelter. As discussed under #5, aromatic chemicals in sagebrush foliage are designed to reduce herbivory, but many animals (especially mule deer and sage grouse) are able to tolerate sagebrush browse, and in fact rely on it extensively in their diet. Sagebrush is an important source of protein for mule deer on their winter range. The Greater and Gunnison sage grouse feed almost exclusively on sagebrush from October to April (their gizzards are not adapted for grinding hard seeds like other upland game birds). Sage grouse also rely on sagebrush for nesting cover and feed their chicks insects, grasses, and forbs that grow under the sagebrush canopy. Brewer's sparrows, Sage sparrows, and Sage thrashers are other "sagebrush obligates" because of their reliance on Artemisia for hiding cover, nesting sites, and feeding areas. More than a dozen other bird species are highly dependent on sagebrush and grassland habitats, including Blackthroated sparrows, Vesper sparrows, Lark sparrows, Green-tailed towhees, Burrowing owls, Short-eared owls, Long-billed curlews, Sharptailed grouse, Prairie falcons, Ferruginous hawks, and Swainson's hawks. At least 16 species of rodents and rabbits feed on sagebrush, as well as hundreds of insect taxa (52 species of aphids alone according to one study).

Big sagebrush is also less responsible for the decline of native grasses and deterioration of range conditions than is often depicted. Anecdotal evidence that sagebrush is significantly more common today than in pre-settlement times is not substantiated by historical records of pioneers and early photographs. One famous photo used in textbooks for years to illustrate the increase of Big sagebrush in the last 130 years actually depicts an area that was recently burned (and thus devoid of sagebrush), rather than a site naturally dominated by grasses. Changes in the abundance, density, and composition of native perennial grasses and forbs since settlement are better explained by past grazing history and changes in climate and fire regimes. Despite decades of removing sagebrush by chaining, thinning, burning, and applying herbicides, sagebrush habitats have rarely been permanently converted to perennial grasslands because shrubs are better adapted to winter precipitation, drought, and grazing pressure. Modern sagebrush systems are being impacted by changes in natural fire frequency from invading annual weeds and conversion to agriculture and urbanization to such a degree that many sagebrush obligate species (especially sage grouse) are in significant rangewide decline. It is surprisingly difficult to find unaltered sagebrush vegetation anymore!

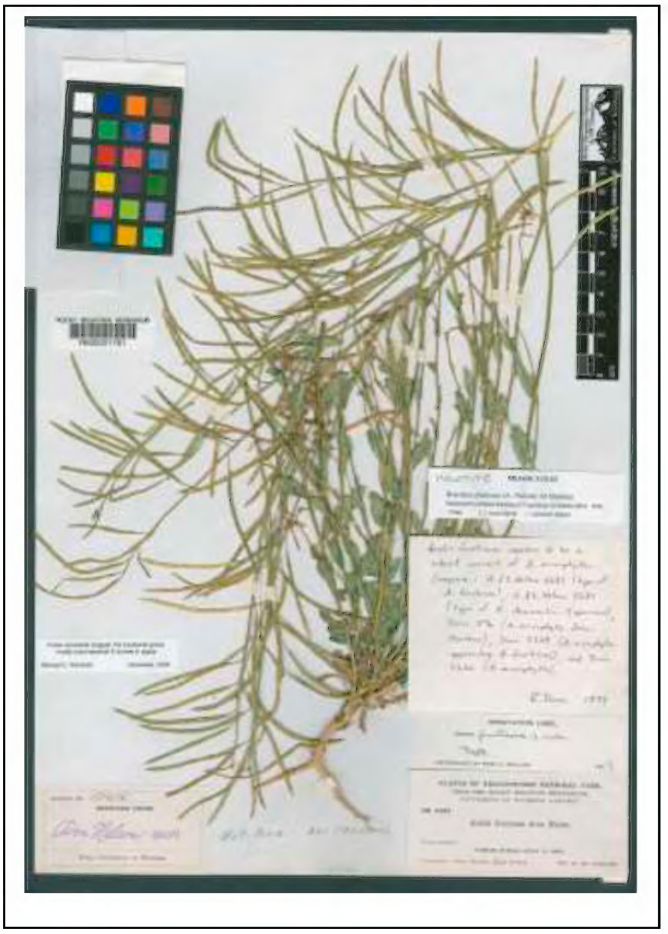
Yellowstone National Park Plants in the Spotlight

Above: *Abronia ammophila* grows on Yellowstone Lake shores

(Editor's note: *Two plant species of Yellowstone National Park were featured in national reports or publications of recent months – for very different reasons.*)

Tweedy's sand-verbena (Yellowstone sand verbena; *Abronia ammophila*) was Wyoming's delegate for the Species at Risk map of NatureServe (2019) as part of their annual report. This first-time map product highlights some of the plant species across North America (north of Mexico) that are potentially globally at risk. *Abronia ammophila* has been documented from about six locations on Yellowstone Lake, at least three of which are known to survive. The map and report to go with it can be viewed or downloaded at: https://www.natureserve.org/sites/default/files/natureserve_annualreport2019_web-map.pdf . More information on the species can also be viewed in the Wyoming Field Guide (http://fieldguide.wyndd.org/?species=abronia%20ammophila).

Yellowstone rockcress (*Boechera fructicosa*) was the only Wyoming plant to be included in a very different roster of extinct (or possibly extinct) vascular plants in the continental United States and Canada (Knapp et al. 2020). *Boechera fructicosa* was discovered by Aven Nelson in his 1899 Yellowstone National Park collecting trip. Three concerted efforts to relocate it over the years have proven unsuccessful, and there have been no confirmed records of it ever since. Compelling cases challenging its taxonomic validity were framed. New genetics tools are being deployed to address its genetics status using the original herbarium specimens, if not provide clues to ongoing search efforts.



Right: *Boechera fructicosa* Greene holotype, collected by Aven Nelson in 1899; posted by Rocky Mountain Herbarium (https://www.rockymountainherbarium.org/)

References

Knapp, W.M., A. Frances, R. Noss, R.F.C. Naczi, A. Weakley, G.D. Gann, B.G. Baldwin, J. Miller, P. MeIntyre, B.D. Mishler, G. Moore, R.G. Olmstead, A. Strong, K. Kennedy, B. Heidel and D. Gluesenkamp. 2020. Vascular plant extinction in the continental United States and Canada. Conservation Biology.

Mystery wormwood; Continued from p. 1

References and specimens were studied before the vouchers were sent off for review. The new locations are 60+ miles northeast of Point of Rocks in northeastern Sweetwater and adjoining Fremont Counties. The shallow swales where *A. b*. var. *diffusa* grows are ephemeral wetlands that may hold clues to its reappearance.

…The *Flora of North America* author of the *Artemisia* treatment, Dr. Leila Shultz, in her review of specimens, also offered a new common name for it that might replace the element of mystery: Dorn's sagewort.

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Dorn, R.D. 1988. Vascular plants of Wyoming. Mountain West Publishing, Cheyenne, WY.

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Fertig, W.,, L. Welp and S. Markow. 1999. Status report on mystery wormwood (*Artemisia biennis* var. *diffusa*) in southwest Wyoming. Prepared for the Bureau of Land Management; posted at: https://www.uwyo.edu/wyndd/_files/docs/reports/wynddreports/u99fer02wyus.pdf

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